ENGINEER, ARCHITECT AND SURVEYOR.

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MEETINGS OF CITY AND TOWN BOARDS.

The Board of Public Works of the City of Chicago is in session from 10 to 12 A. M., and from 2 to 4 P. M., every day, at the City Hall, S. E. cor. of Adams and La Salle streets. Parties presenting plats of subdivisions for approval, will leave them with Otto Peltzer, Chief Draughtsman

The Office of the West Chicago Park Commissioners is at No. 25 South Halsted street, and plats for approval may be presented any day between 9 A. M. and 4 P. M. Chas. S. Loding, Secretary.

The Trustees of the Village of Hyde Park meet at the Town Hall in Hyde Park, on the first and third Mondays of each month, where plats may be presented, or they may be left with Chas. S. Pope, Village Clerk, at Room 16, Kent's Building, 153 Monroe st., before 11.30 A. M. Saturday. Plats approved by the Hyde Park Council are retained for record.

The Board of Trustees of the Town of Lake meets at the Town Hall, at the Stock yards every Monday, from 9 A. M. to 4 P. M.

The Board of Trustees of the Town of Jefferson meets at Jefferson Village on the first Saturday of each month. Plats may be left with S. M. Davis, 43 Bryan Block.

The Trustees of the Town of Cicero meet at the Town Hall in Austin, at 8 A. M., on the second Monday and last Saturday of the month.

Secretaries of the different Boards will do us a favor if they will inform us of any changes that may from time to time be made in the meetings or regulations of their several Boards.

DIRECTORY.

Academy of Sciences—No. 263 Wabash Avenue. Meets second Tuesday of every month, at 7.30 P. M.

Historical Society—209 Michigan Avenue. Dr. Bryeson, Librarian.

Civil Engineers' Club of the Northwest—Meets at the rooms of the Academy of Sciences, the second Monday of each month. E. S. Chesbrough, Pres. L. P. Morehouse, Sec'y.

Free Library—S. E. cor. Wabash avenue and Madison street. Open from 9 A. M. to 9 P. M.

Chicago Chapter of the American Institute of Architects—145 Clark st., Rooms 52 and 53. Meetings, first and third Thursday of each month. President, W. W. Boyington; Vice President, P. B. Wight; Secretary, C. C. Miller; Treasurer, Jas. R. Willett.

PROSPECTUS.

Of the learned professions, the only ones in this country unrepresented by a journal devoted exclusively to its interests, is that of the Civil Engineer and Land Surveyor.

In Law, Medicine and Theology, every school, and every shade of sect and opinion has its exponent which records its progress from year to year and faithfully notes each new development. In Civil Engineering there is an American Eclectic Journal, and several Foreign Periodicals, but these are high in price and addressed only to a few of the most advanced in the profession. To fill the vacancy now existing in the Engineering literature of the country, "The Engineer, Architect and Surveyor" is sent forth, and it will be the aim of the publishers to make it a Journal well worthy of the noble professions which it proposes to represent.

Some of the subjects to be considered will be:

Theoretical and Practical Surveying.

The United States Land System.

The Survey, and Sanitary Improvements of Towns, Cities and Villages.

The Survey and Construction of Roads, Railroads, and Canals, and the Improvement of Lakes and Rivers.

Hydraulic and Mining Engineering.

The Reclamation, Drainage and Irrigation of Land.

The Principles of Design in Architecture.

Proper use of Building Materials.

Construction of Buildings of various kinds.

Mechanical Engineering.

Technical Education.

Besides this list, there will be given well digested reviews of the Real Estate, Iron and Coal Trades; the reports of Scientific societies, Supreme Court decisions in contested surveys; selections from scientific journals, American and Foreign, notices of the latest scientific publications, and such other matter as may be of interest to every civil engineer, architect, surveyor, land owner and general reader.

Arrangements are now being made to secure correspondents in every State in the Union and in Europe, and to obtain the most accurate and reliable descriptions of important Engineering, Architectural, and Surveying operations.

"The Engineer, Architect, and Surveyor" invites the profession to use it as a medium of communication between themselves and the public, and hopes by such mutual intercourse to promote the welfare of themselves and contribute materially to the public weal.

We propose to publish through the year, several maps and will endeavor to fully illustrate the most important articles.

"The Engineer, Architect, and Surveyor" is printed in octavo form on paper 24 x 36 inches, and will be issued monthly, at Two Dollars per annum, payable, in all cases, in advance.

GEO. H. FROST,
CHAS. J. MOORE,
Editors and Proprietors,
168 Washington Street.

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IRRIGATION.

(II).

In Northern India the plains are generally high above the river bed, assuming the forms of *mesas* or table lands, similar to most of our western territories, and this necessitates taking the water from the river and commencing the irrigation canal at a point far up the stream, near its source in the mountains. In Southern India, on the contrary, immense tracts of rich alluvial soil, extend on each side of the river bed at a level not much higher than that of the river itself, and the dam is thrown across the river at its mouth or delta ; the irrigation canals being laid out backwards therefrom, or up the country from the coast line.

In the Madras and Bombay Presidencies also, a very large portion of the country cannot be reached by the canals run up the country from the mouth of the rivers, and these are supplied by very large tanks or storage reservoirs which gather up and store for use the rains of the monsoons falling over an immense area of mountain land. The Indian climate (especially that of the southern portion), being so very variable, necessitated also the construction of these tanks, which are thus enabled to give the necessary supply of irrigation water, even in the greatest droughts. These works are very ancient, and wonderful in their size and the completeness of the system on which they have been carried out. Though some 10,000 of these tanks are now disused and out of repair, there are still 43,000 in use; the average length of embankment being one-half mile, the longest being 30 miles! These embankments are thrown over almost every ravine or canyon, large or small, forming these large tanks behind them. It is calculated that the amount of material in all these embankments is sufficient to encircle our globe with a belt of earth six feet thick, such is their size. One of these embankments in the Island of Ceylon, across a large valley, is 15 miles long, 100 feet wide at base, and 40 feet at top, and is made of immense stones cemented together and covered with earth. In Persia and the valley of the Euphrates, large numbers of canals are to be seen, mostly in ruins, proving that these valleys, once far-famed for their productiveness, only await a vigorous immigration to become as fruitful as ever. As before mentioned, irrigation in Egypt is confined to this class of canals. Owing partly to the configuration of the ground, and partly to the value of the comparatively narrow valley of the Nile, no tanks were constructed in which to store the surplus water of the annual inundations.

In Europe canals are exclusively employed in irrigation systems, although in Spain there are in the mountains, remains of tanks not comparable in size, importance, or extent, however, with those of India. In a few places in Spain adit tunnels are driven into the hill-sides, to tap springs known or supposed to be existing therein, and thus a supply of water is gained for irrigating.

Such irrigating works as have so far been carried out in our own western country are exclusively canals; we think though, that some portions now considered unirrigable may, by a judicious system of tanks, be brought under successful cultivation. It should have been mentioned above that a similar analogy to that between the irrigable portions of Northern India and our Western Territories, exists also between Southern India and parts of our southern States, Texas, Louisiana, Mississippi, Florida, etc. We will now proceed to a more detailed description of the works and methods in use for irrigation purposes throughout the world.

Commencing with natural irrigation we have, as before mentioned, rain, wells, and flooded rivers. With the first of these three sources of water, viz: rain, the Engineer can have but little influence; he can only, and always should, strongly advise against the de-foresting system of settling a country, the harm of which we see to-day only too evident in India. The evils of clearing the land by cutting down the timber wholesale, is so strongly recognized that the Indian Government has now a large body of skilled foresters in its employ, whose sole duty is the conservation of the timber in that empire, and no one is allowed to cut down the trees without the authority of the forester in charge, who points out which tree may or may not be felled.

Previous to the organization of this Forest Department the promiscuous felling of the timber and destruction of the forests had produced drought in many portions of the country which formerly had a temperate climate and were watered by frequent rains. The theory of the use of trees may be explained as follows: All vegetation to support life assimilates certain of the gases which form the atmosphere, and these when liberated form with what was left, certain new compounds of which aqueous vapor is the principal. After a certain time the upper air becomes saturated with this aqueous vapor, clouds then form and rain falls, after which the same process is repeated. If there are no trees in the place, of course this rain forming process can not go forward, and the district is then dependant for rain upon what clouds chance winds may bring with them and thus renders necessary other means of irrigation. In examining a new region destitute of trees to any great extent, the Engineer, with a view to its settlement and development, should report on the advisability of planting trees and offer such suggestions as to their proposed positions, character, and kind as his judgment may direct. This is a duty too often neglected and left to chance. We are glad to see that a movement is now on foot to organize in this country a Forest Department similar to that in India.

Our next point to be considered is irrigation from wells, and here we would draw attention to the article on artesian wells in the Wyoming desert, in our last number, in which this use for such wells is suggested. Some years ago, we believe Gen. Pope, now district commander at Santa Fee, N. M. commenced boring for an artesian well on the arid plateaux of the Llano Estaeado in Southeastern New Mexico, but we suppose with poor success, as the work was abandoned.

We give below a table showing the amount of work done, and cost of raising water by various machines, the first six of which are in use chiefly in Eastern countries.

The machine called the Paecottah in Bengal, or Latha in Southern India, and the Fadouf in Egypt, is simply a long

wooden lever, supported at about 3/8th its length, by an axle passing through it, and resting on the forked end of an upright pole firmly fixed in the ground. To one end of the lever is attached a rope holding a bucket, to the other a wooden counterweight loaded with stone. In India the bucket generally contains about ½ cubic foot.

In Baling two men stand at opposite sides of a small creek, holding by means of small ropes a wicker basket lined with leather, by which they *bale* the water into another channel some five feet above them, then repeat the performance from this channel into another, and so on. Each delivery averages ⅓ cubic foot.

The Moth or Churus is a machine used chiefly in the north-west Provinces of India, and consists in the Single Moth of a leathern bag, raised from a well by two bullocks, walking down a slope. When the bag comes to the top of the well it is emptied into a channel by an attendant, or more generally a leathern pipe is fixed to the bottom of the bag, which can be opened by means of a string by the bullock driver when at the end of the slope, thus dispensing with the attendant.

In the Double Moth two bags are suspended in the same well, the ropes from which pass over two drums arranged on an upright shaft in the form of a whim, which is worked in the usual way by the oxen walking in a circle round the shaft, and one bag lowered while the other is raised. Each bag contains 3 cubic feet.

The Persian Wheel is made of various forms, that of which data are given in the annexed table consists of a chain of buckets arranged (as in our ordinary dredging machines,) over the circumferenee of a large wheel on a horizontal shaft conveying another wheel which gears into a crown wheel on an upright shaft which shaft is driven in the ordinary manner by animals walking over a circular path.

In the Double Persian Wheel two wheels conveying chains of buckets, are fixed on two horizontal shafts over the well which both gear into the same crown wheel fixed on an upright shaft intermediate between them and worked in the same manner as in the single variety above described. Other varieties of this machine are large wheels with buckets *fixed* on their circumference which dip, as an ordinary undershot wheel, into a running stream and deliver the water into a trough above it.

In the Chinese variety alluded to above the arms of the wheel are each formed of two bamboos, fixed about three feet apart to the shaft, and crossing each other at five-eights of their length from the shaft. The ends are joined together by another short bamboo, of larger diameter, open only at one end, and so arranged that when an arm of the wheel is in a horizontal position, this short transverse piece makes an angle of some 15 degrees, with a horizontal line at right angles to the arm: the *open* one being uppermost. As each arm dips into the stream, the transverse piece at its end fills with water, acting as a bucket, and by reason of its peculiarly inclined position, does not discharge its contents until nearly at the highest point of its revolution. The triangular space between the transverse piece at the end, and the junction of the two bamboos forming the arm, is interlaced with a close netting formed of the tough stems of creepers or wicker work, and thus as each arm dips into the stream, the current inpinging upon this netted "float" or "paddle" drives the wheel round, thus making the machine automatic. The ingenuity shown in the construction of this wheel is much to be commended.

In another automatic variety of the Persian Wheel, used chiefly in Spain, the shaft is hollow, and the arms connecting therewith hollow, and of a spiral form. As each arm dips into the stream, it thus takes up water, which, as the wheel revolves, passes up the arm into the hollow shaft, from whence it flows.

The common double action pump (lift and force), we think needs no explanation, and we now therefore refer to the table.

TABLE SHOWING COMPARATIVE PERFORMANCES AND COST OF DIFFERENT MACHINES IN RAISING WATER TO THE SAME HEIGHT, VIZ: 40 FEET.

Number.	Methods.	Stages.	Useful effect—per cent.	Discharge per Hour,		Discharge per Day.		Ratio of Discharges.	Employs		Daily Expense in Dollars.	Quantity of Water raised for One Dollar.		Remarks.
				Cubic Feet.	Gallons.	Cubic Feet.	Gallons.		Men.	Bullocks.		Cubic Feet.	Gallons.	
1	Paccottah, Latha, or Fadout,	2.50	90	29.07	181.4	232.5	1451.5	1.0	2	—	3.00	77.5	483.8	Discharge increased with decrease of height.
2	Baling,	8	75	37.5	236.2	300.0	1875.0	1.29	4	—	6.00	50.0	312.5	
3	Single Moth,	1	70	149.5	924.0	1196.0	7392.0	5.1	1	2	3.00	398.7	2464.0	
4	Double Moth,	1	65	165.8	1045.0	1326.4	8360.0	5.7	1	2	3.00	442.1	2786.7	
5	Single Persian Wheel,	1	55	69.3	429.0	554.4	3432.0	2.4	1	2	3.00	184.8	1144.0	Discharge the same at any height.
6	Double Persian Wheel,	1	60	198.0	1242.0	1704.0	9936.0	6.8	1	2	3.00	568.0	3312.0	
7	Double Action Pump,	1		1133.0	7204.0	9064.0	57632.0	39.7	1	2	3.00	3021.3	19210.6	
8	" "	1		144.0	900.0	1152.0	7200.0	4.9	1	*	2.25	512.0	3200.0	Discharge increased with decrease of height.
9	" "	1		481.0	3005.0	3848.0	24040.0	16.5	1	†	2.75	1400.0	8741.7	
10	" "	1		504.0	3150.0	4032.0	25200.0	17.3	1	††	2.50	1612.8	10080.0	
11	" "	1		72.0	450.0	576.0	3600.0	2.5	1	—	1.50	384.0	2400.0	
12	" "	1	80	634.0	3960.0	5069.0	31680.0	21.8	1	—	3.50	1448.5	9071.4	

* Donkey. † Pair of Mules. ‡ Horse. ‖ One Horse power steam pump and boiler.

In the column of "useful effect per cent." the numbers given are those relating to the machines themselves, and

therefore in methods 7–11 inclusive, these spaces are left blank, because the performances shown for these methods are the *actual* amounts of work done during the day of eight hours, by the various animals employed. The efficiency of the machine employed, a double acting pump, the same in each case, is generally from 80 to 90 per cent., and the pump is manufactured of course, some 10 to 20 per cent. larger than is required theoretically, to pass the amounts of water shown in the columns referring thereto.

The expense items are fixed according to the following prices: Wages of one man $1.50 per diem.

Hire of a donkey, 75 cents per diem.

Hire of one pair of mules, $1.25 per diem.

Hire of one horse, $1.00 per diem.

Hire of one pair of oxen, $1.50 per diem.

The expense, $3.50 per diem, of the steam pump and boiler, method 12 in the table, is determined by charging $1.50 per diem for the attendant, $1.00 for cord-wood or other fuel, and $1.00 for interest on the cost of the machine and incidental expenses.

As it has been compiled and calculated with great care, we trust this table will prove of considerable value to those intending to irrigate from wells.

The various methods of sinking and constructing wells we must leave for other articles.

[*To be continued.*]

THE U. S. PUBLIC LAND SYSTEM.

The close of the revolutionary war found the United States government the owner of an immense territory, whose value, present and prospective, the very practical statesmen of that age were not slow to estimate. Appreciating also the importance of its early settlement and its transfer, under a well defined policy, to individual ownership, the Continental Congress, as early as May, 1784, reported "an ordinance for ascertaining the mode of locating and disposing of lands in the western territory," which, after being discussed and amended for one entire year, was finally passed May 7, 1785, and after being further amended by succeeding legislation, as discovered imperfections rendered it necessary, resulted in the present excellent method of surveying and disposing of the public domain.

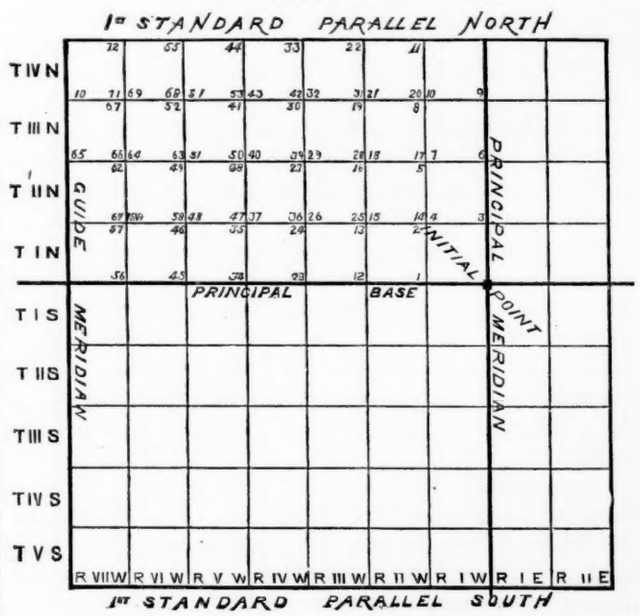
Our remarks in this present article will be confined to the consideration of this rectangular system of survey. We propose, however, to give only the outlines of the method of proceeding; those who expect to be engaged in actual surveys will of necessity study the book of "Instructions," and such other works as are published on the subject, in order to become intimately acquainted with all the details of the system.

In the accompanying diagram A, is shown a PRINCIPAL BASE and a PRINCIPAL MERIDIAN, the intersection of which lines is an INITIAL POINT, or point of commencement of the division of unsurveyed lands in the district in which it may be situated. In locating this point conspicuousness, and nearness to the field of immediate operations are generally considered, and care is taken to ascertain its exact geographical position and to perpetuate it for future use.

From the initial point the principal base is run east and west on a true parallel of latitude, and the principal meridian north and south on a true meridian, each line being marked at every half mile, or 40 chains, with a quarter section corner, and at every mile, or 80 chains, with a section corner, and great care is exercised in the determination of their position and accuracy of measurement, frequent astronomical tests being applied to the one, and an extra set of chainmen used to check the other.

Twenty-four miles north of the base line the first STANDARD PARALLEL NORTH is established, and at thirty miles south of the base line the first STANDARD PARALLEL SOUTH is established. These lines, called also *correction lines*, are run and measured with the same care as the base line, and are used to provide for, or counteract, the error that would otherwise result from the convergency of the meridians, and also to arrest any error arising from inaccurate measurement.

DIAGRAM A.



At forty-two miles east and west from the Principal Meridian a *Guide Meridian* is started from the first standard parallel south and run due north to the first standard parallel north, thus forming parallelograms of twenty-four and thirty miles, by forty-two miles respectively on the north and south sides of the principal base. These principal lines are all shown in the diagram A and together constitute the framework of the rectangular system.

There are twenty-three principal meridians which govern the surveys of the public domain.

OHIO public surveys are controlled by several initial points, and by the 1st Principal Meridian which forms the boundary line between Ohio and Indiana.

INDIANA surveys are governed by the 2d Principal Meridian.

ILLINOIS, 2d, 3d, and 4th.

WISCONSIN, 4th.

MINNESOTA, 4th and 5th.

DAKOTA, 5th and 6th.

IOWA, MISSOURI, and ARKANSAS, 5th.

KANSAS, NEBRASKA, and most of COLORADO, 6th.

MICHIGAN, the Michigan meridian.

FLORIDA, the Tallahassee.

ALABAMA, the Huntsville and St. Stephen's meridians.

MISSISSIPPI, the St. Stephen's, Choctaw, and Washington.

LOUISIANA, east of Mississippi river, the St. Helena, and west of the river the Louisiana meridians.

NEW MEXICO, the New Mexico meridian.

ARIZONA, the Gila and Salt River meridians.

UTAH, the Great Salt Lake meridian.

NEVADA, the Mount Diablo.

MONTANA, the Montana.

CALIFORNIA, the Mount Diablo, San Bernardino, and Humboldt meridians.

OREGON and WASHINGTON, the Willamette meridian.

IDAHO, by the Boise meridian.

The parallelograms which have been described, are subdivided into TOWNSHIPS of six miles square each, containing as near as may be, 23,040 acres, and which are further subdivided into thirty-six sections of a mile square, containing, as near as may be, 640 acres. A tier of townships situate north or south of each other is called a *range*. Townships are numbered north and south of the base line; ranges are numbered east and west of a principal meridian.

[*To be continued.*]

AN ACT

TO REVISE THE LAW IN RELATION TO COUNTY SURVEYORS, AND THE CUSTODY OF THE UNITED STATES FIELD NOTES.

SECTION 1. *Be it enacted by the People of the State of Illinois represented in the General Assembly*, That every county surveyor shall, before entering upon the duties of his office, take and subscribed and file in the office of the county clerk, the following oath:

"I do solemnly swear (*or* affirm, *as the case may be*,) that I will support the Constitution of the United States, and the Constitution of the State of Illinois, and that I will faithfully discharge the duties of the office of county surveyor according to the best of my ability."

§ 2. He may appoint one or more deputies, for whose official acts he shall be responsible, who, having taken the oath required of a surveyor, may perform any of the duties pertaining to the office of county surveyor, and any acts done by any such deputy shall be as valid as if done by the county surveyor.

§ 3. The necessary chainman and other persons must be employed by the person requiring the survey done, unless otherwise agreed, but the chainmen must be disinterested persons, and approved of by the surveyor, and sworn by him to measure justly and impartially to the best of their knowledge and ability.

§ 4. It shall be the duty of the county surveyor, either by himself or his deputy, to make all surveys that he may be called upon to make within his county, as soon as may be after application is made.

§ 5. The county board of each county which has not heretofore procured a copy of the original field notes and plats of the United States surveys of the lands in such county, shall procure such copies from the custodian of the originals of such field notes and plats at the cost of the county. The copies of such field notes and plats which have been or shall be procured hereafter by any county shall be deposited and kept in the office of the recorder of the county, and be at all reasonable times subject to examination by all persons who may desire to examine the same. The county surveyor shall make all surveys, either by himself or deputies, in accordance with the original surveys, and the laws of the United States governing surveys.

§ 6. For the purpose of perpetuating every survey, he shall establish the corners by taking bearing trees and noting particularly their course and distance, and where there are no trees within a reasonable distance the corners shall be marked by stones firmly placed in the earth, or, when that is not practicable, by mounds. He shall also, when requested, furnish the person for whom the survey is made a copy of the original field notes and plat of the survey.

§ 7. Every county surveyor shall provide himself with a well bound book, in which he shall carefully and legibly record and note down every survey made by him, giving the date of the survey, the name of the person whose land is surveyed, the metes and bounds of the land as near as practicable, and the data on which the survey was made. Such record shall be subject to the inspection of every person who may think himself interested, and a certified copy thereof, under the hand of the surveyor, or any successor in office, shall be *prima facie* evidence of the facts therein stated.

§ 8. No act or record by any surveyor, or his deputy, as aforesaid, shall be conclusive, but may be reviewed by any competent tribunal in any case where the correctness thereof may be disputed.

§ 9. It shall be the duty of every county surveyor, or other person having the official record of such surveyor in his possession, to deliver up the said record to his successor whenever he may be applied to for that purpose; and every person, who, having possession thereof, will refuse to deliver the same to such successor, when demanded, shall forfeit and pay one dollar and fifty cents for every day he may detain it after demand, to be recovered by any person who may sue for the same before any justice of the peace of the proper county, one half to the use of the person suing, and the other half to the use of the county.

§ 10. As soon as the present custodian of the original field notes of the United States surveys, transferred from the United States surveyor general's office to this state pursuant to act of Congress, shall complete the copying thereof pursuant to law, and the new state house is ready for occupation by the state officers, said custodian shall deposit said field notes, and the said copies and all papers and documents pertaining thereto, in the office of the auditor of public accounts, and thereupon the office of said custodian shall cease, and said field notes and copies shall be and remain in the custody of the auditor of public accounts, and copies thereof made and certified by him, under his official seal, shall be competent evidence.

Approved March 2nd, 1874.

Among the conditions which affect the decay of buildings, chemical action is frequently more destructive than mechanical action, and thus a knowledge of both the chemical and physical properties of building materials is highly important to those who use the same.

Crystallization is frequently the first process of disintegration that takes place in a body, and especially in the case of wrought or malleable iron, has to be carefully guarded against. This same process is again, in other cases, that of the consolidation of the molecules forming a body, as in the case of the solidification of cements, also the formation of ice.

Silicious and calcareous stones decay more generally by chemical than by mechanical action; feldspathic and slate rocks more by the latter than the former. Silicious stones are generally to be preferred for use under water to those of a calcareous nature.

ASTRONOMY.

APPARENT MOTIONS OF THE HEAVENLY BODIES.

Astronomy is the oldest of the natural sciences, and can show the longest train of discoveries. A wide distance separates the rough impression produced by the first view of the sky, with its stars, luminaries, and planets, from the accurate science that embraces at one glance the past and future history of the earth and of the celestial bodies. To produce the present science of Astronomy, it was necessary to observe the celestial bodies for many centuries; to discover from such observation the real motions of the earth; to define the motions of the planets; to ascend from these motions to the principle of universal gravitation; and from that principle to ascend again to the complete mechanical explanation of all the celestial phenomena in their most minute details.

The study of Astronomy is one of the most important that can occupy the human mind, because it both teaches a vast number of important facts, and also affords an admirable training in the true methods of discovering the laws of Nature.

DIURNAL MOTION OF THE SKY.—In order to form a correct idea of the motion of the stars, we must imagine a line drawn through the centre of the earth, and through the two poles of the sky, forming an axis round which the celestial sphere is supposed to turn. The great circle of this sphere perpendicular to the axis is called the *Equator;* the small circles parallel to theequator, described by the stars in their daily course, are called *Parallels;* the *Zenith* of an observer is the point of the sky vertically over his head, and the *Nadir* is the point directly opposite, and under his feet; the *Meridian* is the great circle that passes through the zenith and poles, and divides into two equal parts the arcs of the circles described by the stars above the horizon, and each star on passing the *Meridian* attains its greatest or least height above the horizon; and the *Horizon* itself is a great circle perpendicular to the vertical, or plumb-line, and parallel to the level of still water at the place of observation.

The height of the Pole is an arithmetical mean between the greatest and least heights of the stars that never set; a circumstance that affords us an easy mode of finding it. Travelers going north, find the height of the North Pole to increase nearly in the proportion of the distance traveled; from which it has been concluded that the surface of the earth is convex, and not very different from a sphere.

The curvature of the earth is sensible at the sea-side; for the sailor approaching the coast perceives first the most elevated points, and afterwards the lower land, which had been at first hidden by the convexity of the earth. The curved surface of the earth produces also the remarkable phenomenon that, at sunrise, the summits of the mountains are seen clothed with golden light long before the sun is visible from the plains.

THE MOTION OF THE SUN.—All the heavenly bodies participate in the diurnal motion of the sphere just described, but many of them possess motions of their own which it is important to note, because they lead us to a knowledge of the true system of Astronomy. The Sun has a proper motion opposite in direction to that of the diurnal motion of the sphere. We may recognise this motion by watching the appearance of the sky, which changes with the season of the year, and undergoes an annual revolution. The stars that lie in the path of the Sun and set shortly after him, are in the course of a few weeks lost in his light, and afterwards rise before him; thus proving that the Sun moves towards them, from West to East. This motion of the Sun has been thus observed for ages, and may be determined with great precision, by noting each day the meridian height he attains, and the time that elapses between his meridian passage and that of the stars. From these two sets of observations may be found the the proper motion of the Sun, in the direction of the meridian, and in the direction of the parallels; and the resultant of these two motions gives the actual motion of the Sun around the Earth. By means of observations of this kind, it has been found that the Sun moves in a path called the *Ecliptic*, which at the beginning of the present century was inclined to the *Equator* at an angle of $23^\circ\ 27'\ 57''$

The change of the season depends on the inclination of the Ecliptic to the Equator. When the Sun, in the course of its annual motion, crosses the equator, he moves along the equator during the course of the day, and as this circle is divided into equal parts by the horizons of every place on the earth, the day becomes everywhere equal in length to the night. For this reason the points of intersection of the ecliptic and equator are called *Equinoxes.* When the Sun, leaving the Spring Equinox, moves northward on the ecliptic, in proportion as he advances along his path, his meridian heights above our horizon increase day by day, and the length of the day increases until he attains his greatest altitude; at this time occurs the longest day in the year, and the northern motion of the Sun ceases, and becomes converted into an opposite motion directed back again towards the equator. This period is therefore called the Summer *Solstice*, and the parallel described by the Sun on the longest day is called the Summer *Tropic.* The Sun, returning towards the equator, crosses it again at the Autumnal Equinox, and still moving towards the south, attains his least meridian altitude on the day of the Winter Solstice. when he describes the parallel called the Winter Tropic, on the shortest day of the year. From this point the Sun commences again to return northwards towards the equator, which he crosses on the day of the Spring Equinox; and so recommences his annual path.

Spring is the interval from the Spring Equinox to the Summer Solstice; from this Solstice to the Autumnal Equinox, constitutes the Summer; the interval from the Autumnal Equinox to the Winter Solstice forms the Autumn; and Winter is the interval from the Winter Solstice to the Spring Equinox. Such is the constant cycle of the seasons, regulated by the motion of the Sun in the Ecliptic.

As the presence of the Sun above the horizon is the cause of heat, it would seem at first sight as if the temperature ought to be the same in Summer as in Spring, and in Winter as in Autumn. This, however, is not found to be the case, for the temperature of a place is not simply the effect of the Sun's presence above the horizon; it depends on the difference between the heat gained from the Sun by day, and the heat lost by radiation into space by night. When the Sun is within a certain distance of the Summer Solstice, either before or after it, the heat gained by day exceeds the loss by night, and therefore the temperature continues to rise after the Summer Solstice, and reaches its maximum on the 26th of July. In like manner, during the long nights of winter, the loss by radiation exceeds the gain from the sun by absorption, and the cold continues to increase, after the Winter Solstice is passed, and attains its maximum on the 14th of January. The mean temperatures of the year occur, not at the Spring and Autumn Equinoxes, but on the 24th of April and 21st of October respectively.

The seasons undergo remarkable variations, according to the position of the observer on the earth's surface.

At the Equator, the horizon divides all the parallel circles into equal parts, and the night at the equator is therefore always equal to the day; at the time of the equinoxes the Sun is in the zenith at noon, and at the time of the solstices the meridian height of the sun falls short of the

zenith by an arc equal to the obliquity of the ecliptic; and the shadows caused by the sun at mid-day have opposite directions in the two halves of the year, which never happens in our latitudes, where the shadows at mid-day always fall towards the north. Hence there are properly speaking, two summers and two winters at the equator; and the same peculiarity occurs, only in a less marked degree, in all places situated at a distance from the equator, less than the obliquity of the ecliptic; and all such places are said to be in the *Torrid Zone.*

Outside the Torrid Zone the Sun never becomes vertical, and there is one summer and one winter in the year. The longest day in the year increases, and the shortest day diminishes, in proportion, as we advance towards the Pole; and when the zenith of the observer becomes distant from the pole by an angle equal to the obliquity of the ecliptic, the sun does not set on the day of the summer solstice.

Still nearer to the Pole, the duration of his presence and absence at the solstices exceeds many days, and even months; and at the Pole itself, where the horizon coincides with the equator, the sun is above the horizon when he is on the same side of the equator as the pole, and he is always below the horizon when on the opposite side of the equator; so that the whole year consists of a single day of six months' duration, and of a single night of equal length.

When we examine carefully the motion of the Sun, we find an inequality in it, so that the intervals that separate the equinoxes are not equal, the summer half of the year being about eight days longer than the winter half: the Sun, therefore, seems to move slower in summer than in winter, his slowest motion occuring on the 1st of July, and his most rapid motion on the 1st of January, the proportion between the motions on these days being as 1059 to 1133.

On examining the apparent diameter of the Sun from day to day, we find that it also changes, like the Sun's velocity, becoming least when the motion is least, and greatest when the motion is greatest: the apparent diameters of the Sun on the 1st of July and 1st of January are found to be as 1059 to 1095. From the preceeding statements, it is evident that the apparent size of the Sun varies only half as much as his apparent motion. It follows that the Sun is not only at different distances from us at different times of the year, as is shown by his varying diameter, but also that he describes his path with a velocity that varies at different times of the year; for if his distance only varied, and not his motion, we should find his apparent size to vary as his apparent motion exactly, which we have seen not to be the case.

The Sun's apparent diameter and daily motion are at a maximum on the 1st of January, when he is nearest the Earth and said to be in *perigee;* while his apparent diameter and daily motion are at a minimum, on the 1st of July, when he is farthest from the Earth, and said to be in *apogee.*

The path, among the stars in the sky, traversed by the Sun is called the Ecliptic, because *eclipses* take place when the Moon, at the full or change, happens to be near this circle.

THE REBUILDING OF THE LEVEES OF THE LOWER MISSISSIPPI.

A NATIONAL WORK.

At this writing the vast tract extending from Cairo to New Orleans, averaging sixty miles wide and six hundred miles long, is overflowed to a great extent by the river; destruction reigns; want and famine sail upon the flood; homeless and houseless the weary fugitives are pushing their way in the wide flat boat across the vast expanse of water, through cane breaks and swamps to the high lands.

The most fertile lands of the nation, embracing twenty-five millions of acres, and equal in area to the States of Vermont, New Hampshire, Massachusetts, Connecticut, Rhode Island, and one-third of Maine, after a century and a half of hard work, are still unreclaimed from the overflow—still swept and devastated by the flood.

We may well ask the question now in earnest—why is this?

The only answer is the fact, that the whole alluvial district of the lower Mississippi has been prostrated by a blow from which it has not recovered. Five years of war and devastation; of levees demolished at a hundred different points by a military necessity; eight years following of an anomalous and chaotic state of society and local government; the nearly bankrupt condition of the South since the war; the depreciation to fifty cents on the dollar of the bonds issued by the States to repair old levees and build new ones; the want of concert of action on the part of the States; these are the causes working the ruin we see to-day; these are reasons, why from all parts of a generous nation, food and clothing, and words of sympathy are being hurried forward to suffering thousands.

What are we to do in the future to avert such calamities?

Holland challenged a might sea to combat, and though repulsed again and again through the centuries by the angry waves, she stands a conqueror to-day, and holds the field of battle. Believing that they had solved the problem as to the best means by which to save their country from the sea, they fought on in the midst of dire discouragements till victory met them. The people living along the lower Mississippi, some years ago solved the problem as to the best means of saving their alluvions from the river. For a century and a half they have struggled bravely and persistently, but they can do no more without the nation's help, and with that help generously and promptly given, this will be the last overflow.

This help given will be an investment from which abundant returns will come promptly, as will be evident from the facts now to be stated.

The alluvion of the Mississippi River below Carne Giradeau with the confluent alluvions of its main tributaries will produce if reclaimed thoroughly, say $350,000,000 annually in cotton, rice and sugar; with the tract unreclaimed, we must import this amount or lose so much from our exports; in either case the nation at large loses more each year two fold that will be required to levee thoroughly and secure from overflow beyond a doubt, this whole tract.

That levees alone will accomplish this result will be shown in a future paper.

The subject is one of great importance not only to those who live along the river, not only to the Engineer looking upon it as an interesting question in Hydraulic Engineering, but to every one of us as citizens of a common country.

It is to be hoped that a generous people who are now contributing so largely towards a temporary relief for the suffering district, will make their benefactions permanent by lending a helping hand in the construction of such works as will stand beyond a doubt against the floods.

E. L. C.

ENGINEER, ARCHITECT AND SURVEYOR.

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CHICAGO, ILL., MAY 15, 1874.

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TO ARCHITECTS.

We have thought fit to include within the scope of our journal, subjects of great interest and importance to architects, and this is the reason of the slight change of title with which our second issue appears, and by which title our journal will henceforth be known. The tendency to specialize alluded to in our last number has appeared as much among architects as engineers, though not recognized as generally. This tendency has had the effect of dividing the architectural profession into those who are specially noted for good construction and those noted for elegant design, and it may be said that as a rule an architect prefers to be noted especially for his ability in the latter of the two divisions. Arguing from history we contend that this division is radically wrong, and that the intimate knowledge of the principles of design and those of construction, which was possessed by the architects of former ages who designed those glorious temples, cathedrals and other edifices, the admiration of all subsequent cycles, ought to be possessed more generally than it is, by the architects of the present day. It is our purpose, therefore, from month to month to give such papers as will aid in effecting this intimate relation between the art of design and that of construction which formerly existed.

To him who has heretofore devoted himself more especially, if not entirely, to the study and practice of artistic principles, we hope to present the principles of sound construction in a simple and intelligible form. To him who has prided himself only upon his good construction, we say that sound construction does not necessarily mean ugly or even plain design, but that the arts of building and æsthetics can be made to harmonize and advance hand-in-hand, as has often been proved.

One of the "planks of our platform," then, will be—the æsthetics of sound construction: another,—the proper use of building materials, and we invite free discussion in our columns, of those and kindred subjects.

LEVEES.

We publish elsewhere a communication on this subject from a valued correspondent, the chief engineer to a large work of this nature on the Mississippi River.

We would here draw attention to this, the first instalment, we hope, of several sound articles on the same subject from the same pen.

Particularly at this time, public attention is drawn to this subject and we earnestly hope that this aroused attention will not be suffered to fall again without first being turned to practical account by devising and carrying out some scheme whereby as our correspondent suggests, the whole of the Mississippi Valley may be reclaimed and successfully defended from such a terrible invasion as recently occurred.

But little is known throughout this country generally, of the nature and great use of these Levees on the Mississippi River, and we feel sure that a series of articles on this subject will prove of much interest to our readers.

OUR NOTE BOOK.

A correspondent asks how we subdivide a quarter section. We answer—having found the center of the section by the rule already stated—we measnre all four of the boundaries of the quarter section to be subdivided, and from the middle points in each run straight lines to the opposite and corresponding points; this method is continued down to the smallest fraction of the section. If our lines run through thick brush or timber, we run straight "random" lines, and "correct" where necessary, but in no case merely run a compass line and plant a post without testing with the chain. Bearings and angles must always be of secondary importance to actual measurement with the chain.

We desire to enter a hearty protest against the miserably low rates paid for surveying, outside of the cities.

The rate per diem of surveying in Illinois is fixed at six dollars, so that a surveyor to make a fair income for himself would have to be constantly employed. How many County Surveyors have an income of one thousand dollars, realized from the practice of their profession? Is it not about time for them to talk seriously with their legislators and urge the propriety of allowing them to make their own prices, and to judge for themselves what is a fair compensation for their services.

In the present number we have devoted considerable space to the laws relating to surveys and other matters of importance to surveyors. We desire to call attention to the section from the United States law relating to the survey of public lands, especially to that part of it relating to the determination of the center of the section. We stated in our April number that there was no exception to the general rule there given; we will modify it by stating that in *fractional* sections where no opposite corresponding corner exists the rule could not apply, and the law just referred to explains the method to be pursued in such case.

We wish to call the attention of our readers also, to our column of "Law and Legislation," which will be continued throughout the entire year. The decisions there given are compiled for this Journal, by John Dunn, Esq., of New York City, a gentleman whose experience is great and varied, in cases of land grant questions and disputed boundaries. These decisions are of great value to every surveyor, and not only so, but to every lawyer who may have occasion to look up the decisions of the courts in land suits, these abstracts form a complete and reliable index.

Our readers will not fail to note the change that has been made in the name and management of our paper. Elsewhere will be found some remarks on the change of name; the formation of a partnership between the Editors necessitated the removal of our Mr. Moore to Chicago, and the temporary closing of our New York office. We have also changed our location to 168 Washington street, where, in our pleasant and commodious quarters we will be pleased to see any of our friends who may be passing through the city. Our enterprise has demonstrated the existence of an actual want of such a paper as we are publishing, and especially so among surveyors and younger civil engineers, and the large correspondence that has been already elicited, and our most encouraging subscription list incite us to renewed efforts to accomplish what we have set out to do, viz: to publish the best journal on practical science in the country.

ANSWERS TO CORRESPONDENTS.

SHAWANO, WIS., APRIL 25th, 1874.

MR. EDITOR:—Please give me your opinion in regard to running "due north" in the subdivision of *fractional* sections. Some surveyors are governed by the meridians of the section boundaries, while others disregard them and are governed by the true meridian only, often making a difference of several degrees in the same line. Which is correct? J. M.

ANS. "Due North" in a *fractional* section means parallel to the east or west boundary of the section, as the case may be. The law assumes that the section lines *are* run on a true meridian, and provides for the use of correction lines to keep them as nearly so as possible. We do not then see by what right any private surveyor assumes to correct the government work no matter how great the error may be. There must be some law from which there is no appeal.

BAD TASTE.

One of the most frequent evidences of this principle, or rather want of principle, is the employment of a material in a structure to perform certain functions, to resist certain strains which we know from its physical properties, it is ill-calculated to bear, without making the parts formed of it, of an uneconomical strength. For instance, all timber (except West Indian Cedar and Teak,) has much greater tensile than compressive strength and stone vice versa, but do we not often see, at least the first of these two materials, used in compression where stone would have served quite as effectively, and have been much better fitted for the position, though its cost somewhat more, perhaps than the former? Another instance of bad taste is disguising materials by paint, or otherwise, to make them appear to be of an entirely different substance in order to harmonize (?) with the adjacent portion of the structure or for some other purpose.

One instance of this which recurs to mind is the case of the storm-doors to the principal entrance to a very large and handsome insurance building in one of the chief cities in the United States. The lower storey of the building is of a handsome grey granite, and the doors are actually painted as nearly as possible in an exact imitation of the stone, thus offending the common sense of every passer by in forcing themselves upon him as a glaring sham. For though to all appearance cut out of stone, yet our common sense tells us that if made of stone, the doors could not withstand any one of the many shocks and slams they get almost every moment during the day, and this irritates our taste at the effrontery of the attempted imposition. Cast iron, also, is often used in our buildings, when in other localities and other countries, where stone is cheaper, that material would be employed. Too often the cast iron is disguised so as to appear as much like stone as possible, even to the form and amount of undercut in the mouldings, enough "to deceive if possible even "the very elect" among architects, which we hold is dishonest in principle. Honesty in design is as much to be followed as the same principle in ethics, and should be always held as one of the most necessary among all that form the principles of good taste.

We have not space to enlarge upon this important subject but will return to it at an early period and treat it with greater fullness.

PERSONAL.

In our April issue, in calling attention to the personal services of J. M. Bourne, Civil Engineer of Springfield, Illinois, we mistook the name, and now desire to make the necessary correction. In the same connection we wish to mention the name of Mr. Zimri A. Enos as being a most worthy coadjutor of Mr. Bourne.

LAW AND LEGISLATION.

An abstract of decisions of the Supreme Court of the United States and of the courts of the various States in the Union upon questions relating to boundaries, surveys, etc.

17. A conveyance of land, described as a tract surveyed for a particular person, passes all within the bounds of the survey. It is, in fact, a conveyance by reference to courses and distances, or metes and bounds, which are as operative to define the subject of the grant, as if they were included in the deed. Per Gibson C. J., Armstrong v. Boyd, 3 Pa. 459.

18. Where land is conveyed by deed referring to a plan, between which and the original survey there is a difference in the location of lines and monuments, the lines and monuments originally marked as such are to govern, however they may differ from those represented on the plan. Ripley v. Berry, 5. Greenl. (Me.) 24 Brown v. Gay, 3 Greenl. 126.

19. Boundary may be proved by every kind of evidence, which is admissible to establish any other fact, and when boundary is ancient, even *reputation* is admissible to prove it. Smith v. Prewit, 2 A. K. Marsh, (Ky.) 158; Smith v. Nowells, 2 Litt. (Ky.) 159. Ancient reputation and possession, in regard to boundaries of streets in a town, are entitled to more respect in deciding on the boundaries of lots, than any experimental survey that may be afterwards made. Ralston v. Miller, 3 Rand. (Va.) 44.

20. Where a deed gives a description, which has not acquired a fixed legal construction, or refers to a boundary which is variable, parol evidence is admissible to explain the deed. Waterman v. Johnson, 13 Pick. (Mass.) 261.

21. As where land was bounded by a pond, which by means of artificial works, was differently raised at different times, it was held that this constituted a latent ambiguity, and that parol evidence was admissible to show that a certain line was agreed on and understood at the time of the conveyance as the boundary of the pond. Waterman v. Johnson, 13 Peck. 261.

22. Where a stake and stones are referred to, as a monument, in a deed or levy, parol proof is admissible to show their location. 1 Shepley, (Me.) 111. See Linscott v. Fernald, 5 Greenl. (Me.) 496. Claremont v. Carlton, 2 R. stamp 373. So also of a tree. Blake v. Doherty, 5 Wheat. 359.

23. Where a deed calls for a course from a point on a river, different from the course of the river, and not calling for it, parol evidence is not admissible to prove that the river was the line which was originally run. Den v. Green, 2 Hawkes (N. C.) 218.

24. In locating a deed upon the ground, the rule is to rely—1, On the actual lines originally surveyed; 2, On lines run from acknowledged calls or corners; 3, On lines run according to the course and distance named in the deed. Avery v. Baum, Wright, (Ohio) 576.

25. What are boundaries described in a deed is a question of law. The place of boundaries is a matter of fact. Doe v. Paine, 4 Hawks, [N. C.] 64. See Cockrell v. McQuinn, 4 Monr. [Ky.] 63; Hurley v. Morgan, 1 Dev. and Bal. [N. C.] 425.

26. Where the boundaries of land are fixed, known, and unquestionable monuments, although neither courses, nor distances, nor the computed contents correspond, the monuments must govern. Pernam v. Wead, 6 Mass. 131; Alshire v. Halse, 5 Ham. [Ohio] 534; Sims v. Baker, Cooke, [Tenn.] 146; Calhoun v. Wall, 2 Har. & McHen. [Mo.] 416.

27. Preference is said to be given to monuments because it is most beneficial to the grantee in giving him more land. Carroll v. Norwood, 5 Har. & J., [Md.] 163.

28. A line is to be extended to reach a boundary in the direction called for, disregarding the distance. Witherspoon v. Blanks, 1 Taylor, [N. C.] 110. See Doe v. Roscoe, 3 Hawks, [N. C.] 21.

29. If a vendor hold two tracts adjoining, and sell a certain quantity by metes and bounds, though the deeds call for one tract, yet if the metes and bound run into the other, the purchaser shall hold according to the metes and bounds. Wallace v. Maxwell, 1 J. J. Marsh. [Ky.] 447. See Mundell v. Perry, 2 Gill. & Johns., [Md.] 206.

30. Posts set up at corners, between adjoining owners of land, control the calls for course and distance, and establish the boundary where they are mentioned and recognized in the deeds. Alshire v. Hulse, 5 Hum. [Ohio] 534.

SURVEYORS' MISTAKES.

The most common reproach urged against the ordinary practice of surveying is inaccuracy. Almost daily is the question asked—"Why is it that no two surveyors can agree in their measurements, or in the location of a line?" And it is not sufficient to answer, that surveyors are not infallible; that lawyers involve their clients in heavy losses of time and money by mistakes; doctors and chemists poison their patients with wrong drugs; and architects plan buildings that are faulty in appearance, and deficient in almost every requirement of comfort, stability or healthfulness; that in the counting-room of the banker, the store of the merchant, the manufactory, the shop of the mechanic, or the fields of the farmer, blundering is the rule, and that where there is one man who understands his business, and does his daily work well, and correctly, and honestly, there are scores who are ignorant of the first principles of their calling, and who, to ignorance, add laziness, dishonesty, or a self-conceit that place them beyond the hope of improvement.

Surveying being considered an exact science, the men who practice it are supposed to be equally exact in their demonstrations of its problems. We believe that while there are much fewer cases of disagreement among surveyors than is generally allowed, yet that there is an abundant cause for reproach in their practice, a great deal of which results from the use of imperfect instruments and untrained assistants, but most of which is undoubtedly the fruits of ignorance and general incompetency. We propose to consider in this article some of the reasons why "no two surveyors can agree."

There are a great many careful and intelligent surveyors in the country, of whose work ninety-nine per cent. would be correct beyond a question if they would throw aside the use of the magnetic needle in running lines and adopt the transit; if they would use a light steel chain, or tape, with improved handles, for correcting the errors caused by stretching or shortening of links or the thickness of the pins; by the use of moderately sized pins; and by always acting as "leader" in chaining. We use in our own practice a patent steel chain, No. 15 wire, and would use no other, it being so light, and accurate, and if broken, easily repaired. We always chain and *always* "lead," as we have never yet found an assistant whose tardy steps we cared to follow, or whose interest in the work was sufficient to insure a taut chain without constant and wearying admonishment.

The important part of surveying is measuring, and when a surveyor sets two farm hands or any ordinary assistants to chaining over rough or smooth ground, up hills and down, through brush, over fences and streams, and the numerous other obstructions that are of daily occurrence, while he walks carelessly along, with compass by his side, giving an occasional direction, then that surveyor does not understand his business, or is dishonest to his patrons, because there is not the slightest probability that the measurement thus made with the ordinary huge, clumsy, Gunter's chain, will be at all near the truth, and on uneven

ground the division of a section line could not be correctly made from it. We consider chaining of the first importance, and we do hope that every surveyor will see the necessity of improvement in the chain itself, and in the use of it.

The sources of error in measuring are, as we suppose is well known, deviation from a straight line, leaning of pins, thickness of pins, neglecting to keep the chain level in going up and down hill, or on rough ground; "kinks," and failing to keep the chain taut with a uniform strain. To eliminate these requires a better instrument than the one now principally used, and then to be careful in the use of it. With these precautions surveyors would agree more closely in chaining the same distance from the same starting point, and in dividing up pro rata between the same points they should agree exactly.

We will, in a future number, consider other sources of error in ordinary practice.

CIVIL ENGINEERS' CLUB OF THE N. W.

At an ordinary meeting of this Club, held in this city on the 12th inst., there were present Messrs. E. S. Chesborough, Pres., L. P. Morehouse, Sec., and a full attendance of members and visitors. After the transaction of general business, the Secretary read a paper, written by himself, on "The Cost of Transportation on Railroads," which, containing many facts of great interest, we give below almost unabridged.

The business of transportation is not as yet an exact science, even the foundations thereof are not universally acknowledged. One of the most important points to be settled is what principles should govern the establishment of charges for transportation to attain reasonable rates. The first inquiry to be made is regarding the cost of doing the business which railroads perform.

The *average* expense of running a train one mile on all the railroads of Ohio, Pennsylvania, Illinois, New York and Massachusetts, for the year 1872, was one dollar, varying from 85 cents on the Ohio roads, to $1.31 on the Massachusetts roads; and this latter amount is an average of amounts varying from 99 to 178 cents. It is unfair therefore to take one dollar as the average cost for any one of these five States, and probably more unfair in the case of any particular road. The law of averages is thus limited in its application. As the prosperity of the Western States depends so largely upon the cheapness of transportation of their products to the Eastern market, we will first ascertain the cost of transportation on Western roads, and take for investigation the Illinois Central Railroad. The statistics of this road for a period of eight years are taken, and from the Reports it appears that the average length of road operated during this period has been 982 miles, and the expense per train mile 94 cents. The business and earnings of this road are less than those of some other western roads, but much more than the average of all. The amount given above, 94 cents, is the average for all trains, passenger, freight, switching, and construction; the expense due to any one of these varies much from that due to another. It must also be ascertained what part of the whole expense is due to actual transportation, and what to the general operation of the road. The former, or the *direct* expense, includes maintenance and service of engines and cars, wages of train men and the like. The latter *indirect* expense includes repairs of fences and buildings, salaries of officers, agents and station laborers, and all expenses bearing no direct relation to actual transportation. We confine our attention at present to the freight business, and find that the direct expense thereof (for train expense), is $10,823,162.10, this sum including train services, fuel, oil, waste and supplies, and repairs of engines and cars—"cleaning engines" is not included. Total freight train mileage is 24,346,440 miles, and thus expense per mile due to train service is 44.45 cents. Expense for maintenance of way must be divided proportionally between passenger and freight trains, according to the damage done by each, and this is in proportion to the weight and speed of trains. Weight of freight trains being about twice that of passenger trains and speed ⅓ less, a freight train of same weight as a passenger train would do ⅔ as much damage to track, and one twice the weight, ⅓ more. Passenger train mileage therefore represents, in regard of maintenance of way, freight train mileage of ¾ that amount. Switching trains represent ⅓ of freight trains, and construction and fuel trains are equivalent to freight trains.

For the 8 years' expense for maintenance of way per mile run of all trains is 25.36 cents.

Mileage of freight trains is 24,346,440 miles; of passenger trains 10,154,387, of switching trains 4,850,252; of other trains 872,759 miles, the total being 40,223,838 miles.

Reducing passenger and switching trains to their equivalent in freight mileage, we have ¾ passenger mileage 7,612,790; ⅓ switching mileage 1,616,751; and with freight and other train mileage as above, we have total freight train mileage of 34,448,740 miles. Cost per mile then would be 29.61 cents, instead of 25.36 cents for all trains as above. The whole of this expense is not due to movement of trains, but part to the action of the weather in destroying road-bed, ties, bridges, &c. The expense may be divided thus: Renewals of rails, all due to trains movement direct, 25 per ct.; Joints, spikes, making frogs and switches, direct 7 per ct.; Ties divided equally, indirect 6 per ct., direct 6 per ct.; Labor on track and track watchmen, (division varying according to character of road bed, &c.,) in this case, indirect 21 per ct., direct 21 per ct.; Repairs of bridges, and bridge watchmen, indirect 8 per ct., direct 4 per ct.; other items, say, indirect, 1 per ct., direct 1 per. ct.; total per centage on division of expenses for maintenance of way, indirect 36, and direct 64; then 64 per cent of 29.61 cents is 18.95 cents this being the direct expense due from maintenance of way for any kind of train equal in speed tons, to the average freight train. As this amount 29.61 cents includes mileage of trains producing no revenue, it must be altered to the proper amount by deducting these trains, thus producing 31.92 cents as total expense from maintenance of way, including 18.95 direct, and 12.97 cents indirect. Direct transportation expenses are for train service 44.45 cents, and for maintenance of way 18.95 cents, making total for moving freight train one mile, 63.4 cents. We assume (as there is in absolute rule,) that the direct expenses are divided between the freight and passenger business in the same proportion as the direct expenses for train service, viz: 73 per ct. to freight and 27 per ct. to passenger business.

Total expenses then are, for train service 37 per ct.; maintenance of way 25 per ct.; other expensas 29 per ct.; axes 9 per ct. This amount for taxes is exceptionally high, as the I. C. R. R. Co. pay 7 per ct. of gross earnings on that portion of its road in Illinois.

Dividing 73 per ct. of the undivided items by the freight train mileage we have 45.47 cents as due to the indirect expenses. Cost per freight train mile is then direct 63.40 cents; indirect, maintenance of way 12.97 cents; indirect, undivided, 45.47 cents; total 121.84 cents. Instead, then, of a train mileage expense of 94 cents as first found, we see that for freight trains, it is about 122 cents, direct expense being little more than half this amount. This expense is due to business of 232,659,672 tons carried one mile, average haul being 142 miles; the earnings are 186 cents per mile.

By the preceeding analysis we see that 73 per ct. of train expenses and 76 per ct. of road expenses are due to freight, and have assumed 73 per ct. of the balance as a proper amount making general average a little over 74 per ct. of total expense. If divided in same proportion as freight and passenger earnings we would have 72 per ct., and if proportion to the absolute mileage of freight and passenger trains, 70 per ct. Taking mileage of passenger trains reduced to freight train basis, we get 76 per ct.

Having found the expense per train mile we now will ascertain the cost pen ton. The average weight of train is about 340 tons, and load 85½ tons, of which 8½ are Company's materials so that paying freight is 77 tons. This proportion of dead weight to load is the same as that reported for the Massachusetts roads for the years 1872 and 1873, their trains averaging 65½ tons of load.

This large proportion of dead to paying weight arises from the impossibility of fully loading the cars for local business and their being sent back empty over the same distance run loaded.

The total expense 121.84 cents divided by 77 tons gives 1.58 cents for total expense per ton, and 63.4 cents similarly gives 8.23 mills for the direct expense.

Average trains consist of 9 loaded cars, 9 empty, and the way car. If a load were secured for one of the empty cars, the additional expense would be very small and as follows; Extra expense of hauling 10 tons additional, original weight of train 340 tons,

1-34 of engine service, except wages, 1-24 of 17 cents, 5 mills; 1-34 wear and tear of track, 1-34 of 18 cents, 5.59 mills; total for *direct* expense 14.34 mills. Expense of loading and unloading we call 14 cents per ton, and with average haul of 142 miles we have for *indirect* expense per mile 10 mills, making total extra cost for 10 tons, 24.34 mills, or less than 2½ mills per ton per mile. A charge of 3 mills per mile would therefore pay a profit on this particular car load.

If another car were put into the train the total extra expenses (for the 2 cars), would be 3.87 mills or less than 4 mills per ton. The cost of moving the whole train including dead weight and load will therefore be for a train of 340 tons, 3.58 mills per ton; one of 350 tons, 3.55 mills per ton; and one of 360 tons, 3.49 mills per ton, the limit to this steady diminishment being the power of the engine. If all the cars can be run loaded, the extra expense would be 9 by 2.434—21.906 cents, and adding the original amount, 121.84 cents, the total would be 143.746 cents, to which we add a profit of 64 cents, and obtain amount to be earned 207.746 cents. Paying load will be 77 *plus* 90—167 tons, and charge per ton 1.244 cents. The original train earning 186 cents, makes a charge for its 77 tons of 2.415 cents; so that, if it was possible to run trains with full cars, charges could be reduced one-half, net earnings still remaining the same.

For the purpose of comparison, we take the report of the operations of the Lake Shore & Michigan Southern Railway, during the year 1872, which being a direct line between the East and West, does a much larger business than the Illinois Central. In 1872, the length of road operated was 1,061 miles, earnings $16,682 per mile, operating expenses and taxes 67 per ct., freight earnings 180 cents, and expenses 121 cents per train mile, earnings per ton 1.37 cents, and expenses .92 of one cent per mile, average haul 208 miles, number of tons paying revenue per train, 128 per mile; number carried one mile 916,855,195 tons.

Analyzing as before, direct expenses are about 60 per ct.; giving direct expense per train mile 72.6 cent., and indirect expense 48.4 cents; and per ton direct 5.5 mills, indirect .7 mills. Tonnage carried eastward was to to that westward in the ratio of 73 to 27; so that, of 73 cars going east loaded, 46 must return empty, consequently we may say that at least ⅓ of all cars run empty. Statistics of other east and west trunk roads are to the same effect; the last report of the Pennsylvania road states that four-fifths of the cars loaded with agricultural produce from the west return empty.

Assuming that in place of 1,000 tons, 1,500 tons could have been carried for the distance which the cars had to run, the charges might have been: For the business actually done, 1,000x137—$13.70; for 500 tons at 2½ mills, $1.25; and for the 1,500 tons $14.95, or at the rate of one cent per ton. The expense would be, actual $9.20; additional $1.25; total $10.45; less than 7 mills per ton.

The Pennsylvania road, with its immense business of $62,000 per mile, for the year 1873, gives the expense per ton as 8.57 mills; an amount largely in excess of that just found hypothetically.

Cost per train mile on the Massachusetts roads in 1857 was 102 cents, in 1872 it was 131 cents, whilst charges per ton were 23.21 cents, and 2.81 cents respectively; expense per ton 1857 was 1.87 cents, and in 1872 it was 1.95 cents. Though actual expense to the roads is more than 4 per ct. greater now than it was seventeen years ago, the public has secured a reduction of over 12 per ct., increase of traffic rendering lower rates possible. The additional expense in 1872 for excess of prices for labor and material over those of 1857, was fully 50 per ct., but business having trebled, and tons per train increased from 54½ to 67, the roads were thus enabled to reduce the rates of transportation. In the case of the Illinois Central R. R., the rates for 1873 were 2.19 cents, against the average of 2.42 cents for the eight years. No reduction can be expected in the prices of labor and materials for the next eight years, nor can any be expected from the substitution of steel for iron rails, as this cannot be accomplished immediately. If it were possible to reduce the weight of cars, to run freight trains at a maximum speed on all roads, of 15 miles per hour, and to switch the cars with greater care, the expenses for track repairs, engine and car service, and repairs, might be lessened. The most likely manner in which transportation rates may be lowered, is in building much fewer roads in the West, and thus, by throwing more traffic on the existing lines, enable them to decrease their rates.

So far we have considered Western local business, with an average haul of less than 150 miles; we will now investigate the questions involved in through traffic between the East and West, with an average haul of 900 miles. It has often been asserted that with a double track, steel road, from Chicago to New York, running freight trains exclusively, ten minutes apart, and at a speed of eight miles per hour, the cost per bushel of wheat could be reduced six cents. The following is an estimate from these and foregoing data, of the minimum charges. Trains each 10 minutes for 16 hours per day, say 100 trains per day; grades and alignment, such that a train may consist of 50 cars, each weighing 8 tons and carrying 12 tons; then weight of train is: paying load 600 tons, dead load 460 tons, working in the year 330 full days. Aggregate tonnage east, say, 18,000,000 tons. The total weight of Illinois Central trains was 340 tons, and direct expense per mile 63.4 cents; direct expense for each additional ton was 1.434 mills, so that for these trains under consideration, we should have, Expense of 340 tons, —63.4 cents, and of 1,060 tons *less* 340 tons—720 tons, at 1.434 mills,— 103.2 cents, then total direct expense is 166.6 cents. The sum of 63.4 cents includes 12 cents for rails, joints and labor on same, which, by using steel in lieu of iron, will probably reduce this amount five-sixths, or to 2 cents, but from the low rate of speed, we reduce this half, viz: 1 cent. Decrease in speed again increases amount per train of wages, as number of men employed per train mile will be greater; this item therefore, which is 13 cents in preceding analysis, we increase by 7 cents. The direct expense, 63.4 cents, is thus increased 7 cents for wages, and reduced 11 cents for rails, being a decrease of 4 cents, or 6.3 per ct. Deducting 6.3 per ct. from 166.6 gives 156.1 cents for the direct train expense for a full train of 50 cars carrying 600 tons going east. For the 50 cars returning (taking eastern and western freights as 75 per ct. and 25 per ct. respectively of the total tonnage), we have only 300 tons of paying load, and total train weight of 660 tons. The cost would be for 340 tons, 63.4 cents; 320 tons at 1.434 mills, 45.9 cents; a total of 109.3 cents. Deducting 6.3 per ct. or 6.9 cents we have for the return train 102.4 cents, and adding thereto the full train 156.1 cents, we obtain 258.5 cents as cost of 800 tons, or at the rate of 3.23 mills per ton.

On the Lake Shore & Michigan Southern road, the indirect expenses are about 40 per ct., taking half of this, or 20 per ct., for our hypothetical road, we have .81 mills, and total expense would then be 4.04 mills. Estimating cost of road at $150,000 per mile, net earnings should be $15,000 per mile, to be earned by a traffic eastward of 18,000,000 tons, and westward 6,000,000 tons, in all 24,000,000 tons. For the net earnings we must thus add .93 mills, bringing gross earnings up to 4.67 mills, allowing for possible interruptions to the continuity of the traffic, we fix the minimum average rate at 5 mills, or half cent per ton mile. The cost for 900 miles will then be $4.50, or 13½ cents per bushel. The amount of business supposed is much larger than can be transacted, without greatly increased facilities for unloading at the East, and is about the same as the united total in 1872 of the traffic on the Erie Canal, and the Erie, New York Central and Pennsylvania Railroads.

On the Illinois Central road we notice that the gross earnings are about $8,600 per mile of road, operating expenses and taxes about 63 per ct., leaving $3,200 as profit. This is 10 per ct. on $32,000 per mile, a sum much less than the actual cost of the property. The cost of all Western roads has averaged $50,550 per mile, and for the year 1872 their net earnings were 10 per ct. on $23,440 per mile.

As regards reasonableness of rates these statistics show; 1. The charges yield less than 10 per ct. on the cost of the property. 2. A rate of 2.415 cents per ton might be reduced to 1.244 cents, if all the cars could be run fully loaded. 3. A rate of 1.58 cents would pay expense of operating road, but leave no profit. 4. A rate of 8.23 mills would pay actual expense of transportation. 5. A rate of 3 mills would pay a profit on any particular freight loaded into cars that would otherwise run empty. 6. A rate of 3 mills per ton would make a charge for 100 miles, of 1½ cents per 100 lbs.; a sum too small to be with collected on any particular lot of that weight.

If others than those who own and operate the roads were to fix the rate,

they should observe the following considerations in regard to each road, and each particular portion of a road.

1. *Value of the road.* One costing $60,000 per mile requires twice the amount of another costing only $30,000 per mile. 2. *Number of loaded cars that can be hauled by one engine.* If only 20 cars can be taken, locomotive expenses would be twice as much as when 40 cars are taken. 3. *Amount of tonnage.* We have seen above that a charge of 2½ cents for one given amount may be quite as reasonable as ½ cent for another. 4. *Tonnage in each direction.* If the cars could be fully loaded both ways, the charges might in some cases be reduced one half. 5. *Character of business;* whether confined to a few principal articles, or of a miscellaneous nature. 6. *Length of haul.* Expenses for receiving and delivering have no reference to distance; the Massachusetts roads with a haul of 49 miles and tonnage of 560,000,000 miles have an expense per ton 30 per ct. greater than the Illinois Central with a tonnage of 230,000,000 miles and a haul of 142 miles. 7. *Terminal facilities.* Expenses for loading and unloading, switching, &c. vary greatly a different stations, from a variety of causes.

The legal application of these principles do not always act with perfect justice both to the railroads and the public. Take two roads, completing at different points, the result of a comparison between their cost, amount of business, facilities for its transaction, &c., showing that one might properly charge 3 cents, and the other 2 cents; the poorer road to obtain any business, at competing points, must lower its rates ⅓, and if required by law to charge on the whole line in proportion to its minimum rates, would be forced to do its whole business at ⅔ of the rate allowed by law. If it declines to take the rates of the other road at these points it must give up all business and profit therefrom, and either obtain higher rates than would otherwise be necessary at non-competing points, or operate at less than a fair profit to its owners. If the public realized more generally that a railroad is a property invested in by individuals who look for as fair a return therefrom as from any other business, and that it is not a mere machine owned by nobody in particular, injuring the industrial interests by its enormous aggregate charges, the reasonable part of them would concede that it is unreasonable to demand that either corporations or individuals should transact business for others without a fair compensation, and would sustain the decision of courts, that one class of business men may not secure the confiscation of the property of another class.

The legislation of the future will abandon the attempt to protect the interests of the public by the establishment of arbitrary rates; but as railroads are of a *quasi* public character, it is not unlikely that a limitation may be placed upon the amount of their net earnings based upon the value of the property.

We hope to be able to notice further, next month, the paper read at the meeting of the Civil Engineers' Club on the 13th ult., by Mr. Chas J. Quetil, C.E. on a novel method of stiffening suspension bridges.

COLORADO SPRINGS.

We are glad to see that an University is about to be established at Colorado Springs. The successful endowment and founding of the chairs in this University, and filling them by Professors most fitted for the same, will form a climax to the wonderful energy and perseverance which has marked this town ever since its commencement. The writer passed through the town, which then consisted of but little more than two short streets of houses, in January, 1872, going south. He was there again in the following July, and the change, even in those few months, was most remarkable. Since then its development has been still more rapid, and now it numbers about 3,000 inhabitants, in a thoroughly well organized community. We hope on some future occasion to give a description of the irrigation works carried out in and around the town.

ACADEMY OF SCIENCES.

A regular meeting of this Society was held on the 12th inst., Dr. H. A. Johnson presiding. After the transaction of some general business, Prof. Colbert read a paper on the velocity of light, in which he expressed the opinion that the theory now abandoned of measuring it by means of the moon's rays reflected from the earth's surface, would at some future time be again attempted, and successfuily. He stated that he had proved by calculation, that could a mass of light equal in brillancy to that of the sun, and only fifty-three feet in diameter, be generated, it would be observable on the moon. The fires of 1871 (both in the forest and city) had consumed sufficient carbon and oxygen to maintain such a light for three months.

Gov. Bross followed with an interesting paper on the Mississippi floods, in which he drew the same conclusion as that advanced by a valued correspondent in an article on the Mississippi Levees, published on another page in this number of our Journal. The author also stated much that diversity existed among the *cognoscenti* about the question whether in the case of large rivers varrying much sediment, the bottom of the river was *scoured* by the current if the stream was confined between levees, or whether it was *raised* by the sediment being deposited thereon, as in the case of the Po and Nile, the body of the former being in some places 15 to 20 feet above the surrounding country. In the case of the Mississippi, Col. Foster held the former opinion (in which we are inclined to agree), while the steamboat captains of St. Louis held the reverse, and advised that the Bayous should be left open to furnish outlets for any innundation. In the discussion which followed the paper, Prof. Andrews stated that the sediment deposited by the Mississippi amounted to from three to four feet in four or five years, and advised to keep the levees as long as possible, and to levee the bayous, keeping them open to the gulf (this appears to be the most advisable course to be pursued). Both he and Prof. A. D. Hager (formerly State Geologist of Vermont), were of opinion that the bed of the river would shortly change.

Prof. Andrews then made a few remarks on geology, in which he stated that there was an intervening period between the post-pliocene and the present. The post-pliocene was marked by a black soil like peat, underlying a large portion of Chicago, and inhabited in Europe by paleolithic man, and in this country by the mastodon. The period which followed was one of high water in the lakes and Mississippi, in which Lake Michigan rose sixty feet and then receded thirty feet and formed another beach. The dead trees of this period lie some eight or ten feet below Chicago, and in his opinion the Lake Champlain deposits decidedly belong to this time.

After attending Prof. Delafontaine's spectroscopic analysis of blood the Academy adjourned.

CHICAGO LICENSED LAND SURVEYORS.

From the Act approved Feb'y 13, 1863, *Chap.* 6, *Sec.* 6.

The said Board of Public Works shall have power, upon application being made to them by any citizen, of whose character and qualifications satisfactory evidence shall be produced, to give such applicant a license, under the corporate seal, to act for two years as a Land Surveyor in said city, and for each license so granted, said Board shall require a fee of ten dollars to be paid into the city treasury. Surveyors so licensed shall take the same oath required by law to be taken by the County Surveyor, and shall give bond to the City of Chicago, with two sufficient sureties to be approved by said Board, in the penal sum of twenty-five hundred dollars, conditioned for the faithful performance of the duties of a Land Surveyor, and the payment of all damages that may be sustained by any individual for whom such services may be rendered, in consequence of the carelessness, misconduct or incompetency of such Surveyor. Said bond shall be filed in the office of said Board, and suits may be brought and recovery had thereon in the name of said City, by any party who may have sustained damages as above mentioned; but said City shall in no case be held liable for the costs of such action, nor for any delinquency, fault or misconduct of such Surveyor. The license to be granted as above provided, with a certificate of the aforesaid oath subjoined thereto, shall be recorded in the office of the Recorder of Cook County; and then and not before, the person so licensed shall have full power and authority, for the term of two years from the date of such license, to make surveys within the city limits, and like effect and validity shall be given to his acts, and to all plats and surveys made by him, as are or may be given by law to the acts, plats and surveys of County Surveyors: *Provided*, that the Surveyors so licensed shall be governed by such laws of the State of Illinois and such ordinances of the City of Chicago, prescribing the mode of Surveying, as are now and may hereafter be in force: *And provided further*, that the said Board of Public Works, shall have power to revoke any license granted under the provisions of this section, upon satisfactory evidence being presented to them of the incompetency or official misconduct of the person licensed.

From the Amended Act approved March 9th 1867, *Chap.* 6, *Sec.* 8.

All Land Surveyors, licensed by the Board of Public Works, in pursuance of Sec. 6 of Chapter 6 of the Revised Charter, approved February 13, 1863, shall have the same powers to make surveys within the County of Cook as they may have within the City of Chicago, and like effect and validity shall be given to their acts, plats and surveys as are or may be given to those of the County Surveyor.

SURVEYS OF PUBLIC LAND.

SECTION 41 FROM ACT 11 FEBRUARY, 1805.

The boundaries and contents of the several sections, half-sections, and quarter-sections of the public lands of the United States, shall be ascertained in conformity with the following preambles, any act or acts to the contrary notwithstanding.

1st. All the *corners* marked in the surveys, returned by the Surveyor-General, or by the surveyor of the land south of the State of Tennessee, respectively, shall be established as the proper corners of sections, or subdivisions of sections, which they were intended to designate; and the corners of half and quarter sections, not marked on the said surveys, shall be placed as nearly as possible equidistant from those two corners which stand on the same line.

2d. The *boundary lines*, actually run or marked in the surveys returned by the Surveyor-General, or by the surveyor of the laud south of the State of Tennessee, respectively, shall be established as the proper boundary lines of the sections, or subdivisions, for which they were intended, and the length of such lines, as returned by either of the surveyors aforesaid, shall be held and considered as the true length thereof. And the boundary lines, which shall not have been actually run, and marked as aforesaid, shall be ascertained, by running straight lines from the established corners to the opposite corresponding corners; but in those portions of the fractional townships, where no such opposite corresponding corners have been or can be fixed, the said boundary lines shall be ascertained by running from the established corners, due north and south, or east and west, as the case may be, to the water course, Indian boundary line, or other external boundary of such fractional township.

3d. Each section or subdivision of section, the *contents* whereof shall have been, or by virtue of the first section of this act, shall be returned by the Surveyor-General, or by the surveyor of the public lands south of the State of Tennessee, respectively, shall be held and considered as containing the exact quantity expressed in such return or returns; and the half sections and the quarter sections, the contents whereof shall not have been thus returned, shall be held and considered as containing the one-half or the one-fourth part respectively, of the returned contents of the section of which they make a part.

Book Notices.

An Elementary Treatise on Steam, by John Perry, B. E., Whitworth Scholar, &c. Published by Macmillan & Co., London, Eng., and Broome Street, New York. 412 pp. Price $1.50.

This very useful and compendious little work is divided into four parts. Part 1, treats of heat or the physics of steam. Part 2, of the practical application of steam to engines generally, especially those of a stationary class and their boilers, entering pretty exhaustively into the details of both engines and boilers. Part 3, is devoted entirely to locomotives, and Part 4, to marine engines, screw propellers, paddles, &c. These are followed by some miscellaneous exercises on useful questions of a kind often likely to occur in practise; next by an Appendix, which contains the papers in the examination in steam by the Science and Art Department of South Kensington, London, and some useful tables, among which is one of hyberbolic logarithms, another of diameters and areas of circles, and a blank form of the log books kept by marine engineers. The work is closed by a carefully compiled index.

Though stated in the preface that this book is intended for the instruction of students, it is in our opinion of great service to engineers in active practice, as it presents in a compact and concise form many facts and formula that are frequently found scattered over several different works, when searched for by the inquiring engineer.

The many important physical facts concerning steam are stated in Part 1, in a simple and concise manner, and the various properties of steam and the intimate and reciprocal connection between work and heat are very forcibly and carefully examined, and illustrated by well chosen examples. The method used by the author in treating of the work performed by steam under the influence of heat is the same as that adopted by the latest writers on the subject, but he states in the preface that he wrote this book two years ago, and that it has been in the hands of the publisher until now. We do not think however that he can claim this novelty in treatment as his own, which is the inference to be drawn from his remarks in the preface.

In the arrangement of the subject we find but little to complain of,; that most important matter, however, the *indicator*, should, we think, have had a separate chapter to itself instead of being partially treated of in two or three different portions of the book. Nevertheless we are bound to state that the use of the indicator diagrams are fully explained throughout the book though not all in one place. Useful exercises for prac-

tice by the student on the physics of steam, &c., are given at the end of almost every chapter in the first part.

Part 2 opens with a concise history of the steam engine, touching on all the salient points from Hero's first practical application of the expansive force of steam, 120 years B. C., to the modern compound engine. This is followed by various chapters describing and giving rules for the construction of the various details which form a complete steam engine, including the boiler. These are followed by various important chapters upon superheating, draught, grate, &c., and the different appendages of the boiler, and this part is closed by very useful and exhaustive chapters on the means and methods of calculating the efficiencies of both engine and boiler. Those three chapters on these two subjets are the most valuable to the practical engineer, of the whole work; for the *true* methods of determining *accurately* the efficiencies of engines and boilers, are not understood and practiced as thoroughly by the average engineer as they should be, and we earnestly recommend a careful study of chapters XV, XVII and XVIII, to such as are not perfectly posted on this subject. In the reference to various descriptions of grates, we should have preferred more extensive notice of the various mechanical grates which have been proposed, and of those which are in use, for among the practical improvements in the immediate future, for economizing fuel and saving labor, this undoubtedly is one.

In Part 3 the locomotive engine is treated of generally and in detail, in a plain and practical manner, but we think that here as elsewhere throughout the book, the differences between American and English practice are not sufficiently shown, in fact the references thereto are very few, nnd scarcely more than mere cursory remarks. Permanent way is disposed of in very few pages, as the author remarks that its consideration "really belongs to another province of engineering." We should have liked, also, more extended notes on the "Fairlie," or double locomotive, than are here given, as of late years it has so successfully held its own on narrow-guage roads, "against all comers," with great *eclat*.

In Part 4, the marine engine, boiler, and the various forms of propellers are explained, and practical rules given for their construction, with the same care that is evidenced generally throughout the book. As in the cases of the locomotive and stationary engine, diagrams are here given, showing the various forms of screw and paddle engines most generally in use; but here also a little more attention to American practise would have been advantageous.

Though in the main the remarks are based upon, and examples drawn from English practise, the whole book is likely to be of great use to any American engineer, and we cordially recommend it to those of our readers who are mechanical engineers, or in whose practice a thorough knowledge of the steam engine is occasionally required; for more useful and *practical* information is contained in this book than many others of three and four times its cost.

In conclusion we must here draw the attention of the publishers to several small typographical errors which we hope will be corrected in the next edition. The work is fully illustrated throughout, where necessary, by neat diagrams and engravings on wood.

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Throughout the United States and the Dominion of Canada, there are certain places which, by their location and natural advantages, are peculiarly adapted to the development of some great manufacturing enterprise. There are mineral regions which only need to be placed in a strictly truthful position before the public to be appreciated and attract the attention of capitalists. There are great tracts of agricultural and grazing lands in the South and West which are practically unknown, but which, if properly brought to the notice of the right parties, would soon create a demand therefor, and ultimate settlement.

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